

**Required Survival Rate Changes to Meet Technical Recovery Team  
Abundance and Productivity Viability Criteria  
Interior Columbia Populations  
May 17, 2006**

In this document we describe the “gap” in abundance and productivity between current status and IC-TRT abundance and productivity goals. We briefly describe the difference between TRT viability goals and delisting criteria, summarize the analyses we conducted and describe their use in assessing overall ESU status. We also present some general conclusions from these analyses, and finally, provide ESU and population-specific methods and results.

**Viability, delisting and recovery**

- Technical Recovery Teams (TRTs) define biological viability criteria or recommended biological goals – these describe the biological characteristics of ESUs and their constituent populations that are likely to yield long-term persistence. NOAA Fisheries delisting criteria and broad sense recovery goals are policy constructs that consider biological goals, mitigation of threats, legal obligations, risk tolerance and other considerations.
- TRT viability recommendations have been used and applied by local recovery planners throughout the Pacific Northwest.
- The TRT viability criteria incorporate the four VSP parameters: abundance, productivity, spatial structure and diversity. All four parameters are critical for population and ESU viability.

**Quantifying needed changes to meet biological viability criteria**

- All four VSP parameters contribute to overall population and ESU viability. The ICTRT uses several metrics to describe risk levels associated with spatial structure and diversity. These metrics do not lend themselves well to generating a single summary statistic to quantify a gap, and thus are not included in this document. They are described in current status assessments.
- The change from the current condition that is required to meet TRT viability criteria for abundance and productivity can be estimated quantitatively. This change has been referred to informally as the “gap”, and addresses the VSP parameters abundance and productivity. Preliminary results for six listed ESUs are summarized in the following sections, and are presented to inform ongoing discussions.
- A key part of the “gap” calculation is the productivity of the population. We use a measure of productivity that directly relates to the potential ability for a population to be self sustaining. The productivity measure used in the gap calculations is expressed in terms of recruits per spawner or the rate at which spawning adults in one generation are replaced by spawning adults in the next generation.
- This measure of life-cycle productivity is affected by mortality and survival at all life stages, including juvenile mortality (such as the relative number or proportion of

juveniles that die while migrating down river) and by adult mortality (such as the relative proportion of adult fish harvested) (Figure 1).

- The gap analyses themselves do not identify or target a particular life stage for actions to achieve viability criteria. Gaps can be addressed by improvements to survival rates at any life stage (e.g., tributary residence, migration, estuarine, early ocean, upstream migration). Formal limiting factors analyses would be the starting point for identifying effective actions.
- As a first step, the TRT is engaged in modeling efforts to assess the impact of several factors that may affect the change required from current status, including improvements to survival through the hydropower system, and alternative early ocean survival scenarios which include effects of ocean condition and any delayed or latent mortality attributable to the hydrosystem.
- Studies have indicated lower relative effectiveness of hatchery origin spawners in natural settings in comparison to adults of natural origin. The relative difference in effectiveness has been linked to the degree of difference (level of domestication, etc.) associated with the hatchery stock. For these preliminary gap analyses, we did not directly incorporate relative effectiveness adjustments for hatchery spawners. We do provide examples of the potential impact on gap calculations for Upper Columbia steelhead.

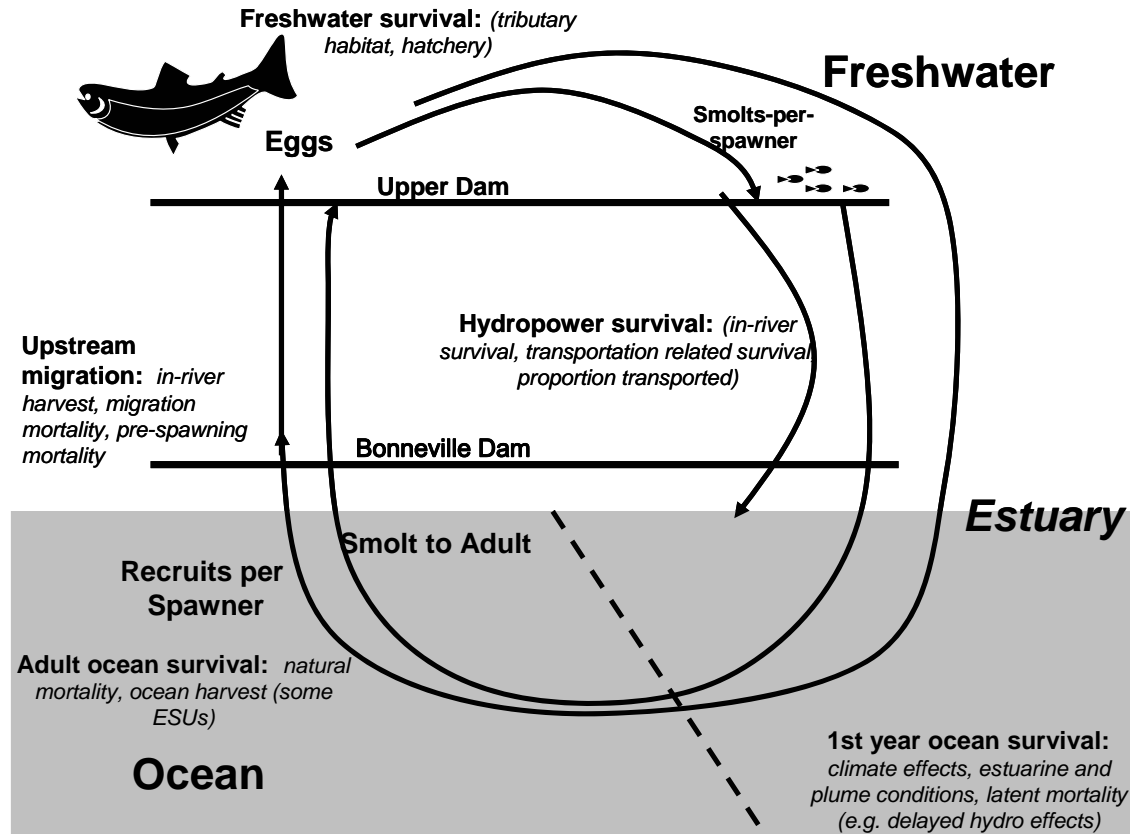


Figure 1. Generalized life cycle for Interior Columbia salmon and steelhead, with factors that contribute to mortality at each stage. The productivity measure (recruits per spawner) that we use encompasses mortality at all stages.

### Interpreting the changes needed.

Because the calculations of productivity and abundance we use require several generations of data, the ‘observed gap’ between those measures and TRT viability criteria do not necessarily reflect survival and productivity under current hydropower management and operations. Similarly, changes in early ocean survival rates or scenarios have the potential to affect strongly the estimate of the gap. Thus, we estimated the gap under three different kinds of scenarios (schematics describing these scenarios are shown in Figures 2 and 3):

- **Observed Gaps:** These are the empirical estimates of the required change in survival to meet ICTRT abundance and productivity goals (i.e., the gap reflected in data from the most recent 20 years, and identified in the ICTRT’s working current status assessments).
- **Direct Hydro Adjustments:** Estimates of survival through the hydropower system for the past 5 years have been consistently higher than the recent twenty year average. As a result, gaps for affected populations may have been reduced. The

Direct Hydro Adjustments scenarios are run under the assumption that the recent improvements in survivals will continue. Future returns will allow us to evaluate whether these improvements have been realized.

- ***Projected Gaps Under Alternative Early Ocean Survivals:*** Because early ocean survival has a strong effect on life-cycle productivity, we modeled a range of scenarios at this stage (see below).

Ongoing and future degradation in other arenas (e.g. freshwater habitat, etc.) may also alter survival rates. In addition, restoration and protection measures and other actions aimed at salmon recovery could reduce the gap. We have not developed scenarios to address these issues, as specific data about the rates and consequences of such changes are not robust. Because of all these factors, the effective survival needed to realize ICTRT abundance and productivity goals may be greater or less than the current observed gap. Thus, an adaptive recovery strategy will be important as we move forward in recovery planning.

### **Early ocean survival scenarios – modeling alternative futures**

Early ocean survival is a critical component of overall life-cycle productivity. This stage includes both natural and anthropogenic mortality in the ocean and in the estuary until the fishes' third birthday, and any latent mortality attributable to the hydropower system. We examined first, a variety of ocean and in-river indices potentially predicting early ocean survival. In addition, for each set of indices chosen, we examined a range of scenarios affecting that survival (details provided in accompanying draft: "Assessing the Impact of Anticipated Hydropower Changes and a Range of Ocean Conditions on the Magnitude of Survival Improvements Needed to Meet TRT Viability Goals").

- ***Incorporating alternative factors predicting early ocean survival.*** We assessed three kinds of models that predicted the value of this important life stage, and their impact on the gap.
  - *PDO Index model:* This model is based upon a strong statistical relationship between estimated estuarine/early ocean survival and the Pacific Decadal Oscillation Index (PDO). The PDO based model has the best statistical fit to the survival data of the single factor models considered in the analyses. If PDO is a primary predictor of this life stage, this longer time series has the advantage of capturing more cycles or oscillations at this stage.
  - *Multiple Index model:* We also employed a model incorporating multiple indices of environmental conditions during outmigration and early ocean residence: the PDO (May); an index of Columbia River water travel time (WTT); and an index of coastal upwelling. The WTT variable describes historical changes in the migration corridor that may affect survival in the ocean. This model explained a higher proportion of the variation in the data series, but estimating longer term patterns in index levels is hampered

by the relatively shorter data series for the non-PDO components of the proposed model.

- *Explicit Latent Effects Model:* We are currently exploring methods to incorporate explicitly a range of potential latent effects attributable to the hydropower system.
- ***Alternate Environmental Scenarios*** At this time, it is not technically possible to identify the most likely specific future conditions for any of these alternative predictors. Thus, for those ESUs with sufficient available information, we provide estimates of gaps given three alternative future environmental scenarios that bound a likely plausible range of future scenarios.
  - *Recent:* Ocean survivals over the next hundred years have the same characteristics (average and year to year variations) as those experienced over the time period of our current status assessments (brood years 1978-1999; outmigration years 1980-2001).
  - *Historical:* Ocean survivals over the next hundred years have the same characteristics (average and year to year variations) as those experienced over the past 50 to 100 years (length depends on availability of specific index data).
  - *Pessimistic:* Ocean survivals over the next hundred years have the same characteristics (average and year to year variations) as those experienced by the 1975-97 brood years. These years corresponded to extremely poor climatic conditions and poor measured early ocean survival rates.

For Mid-Columbia Steelhead, Snake Fall Chinook and Snake River Steelhead ESUs, the records available and the lack of pre-existing analyses make it much more difficult to generate estimates based on longer term climate effects. Therefore the results are shown only for climate influences during the recent (relatively poor) conditions. However, work is continuing on possible approaches for application to populations within these ESUs.

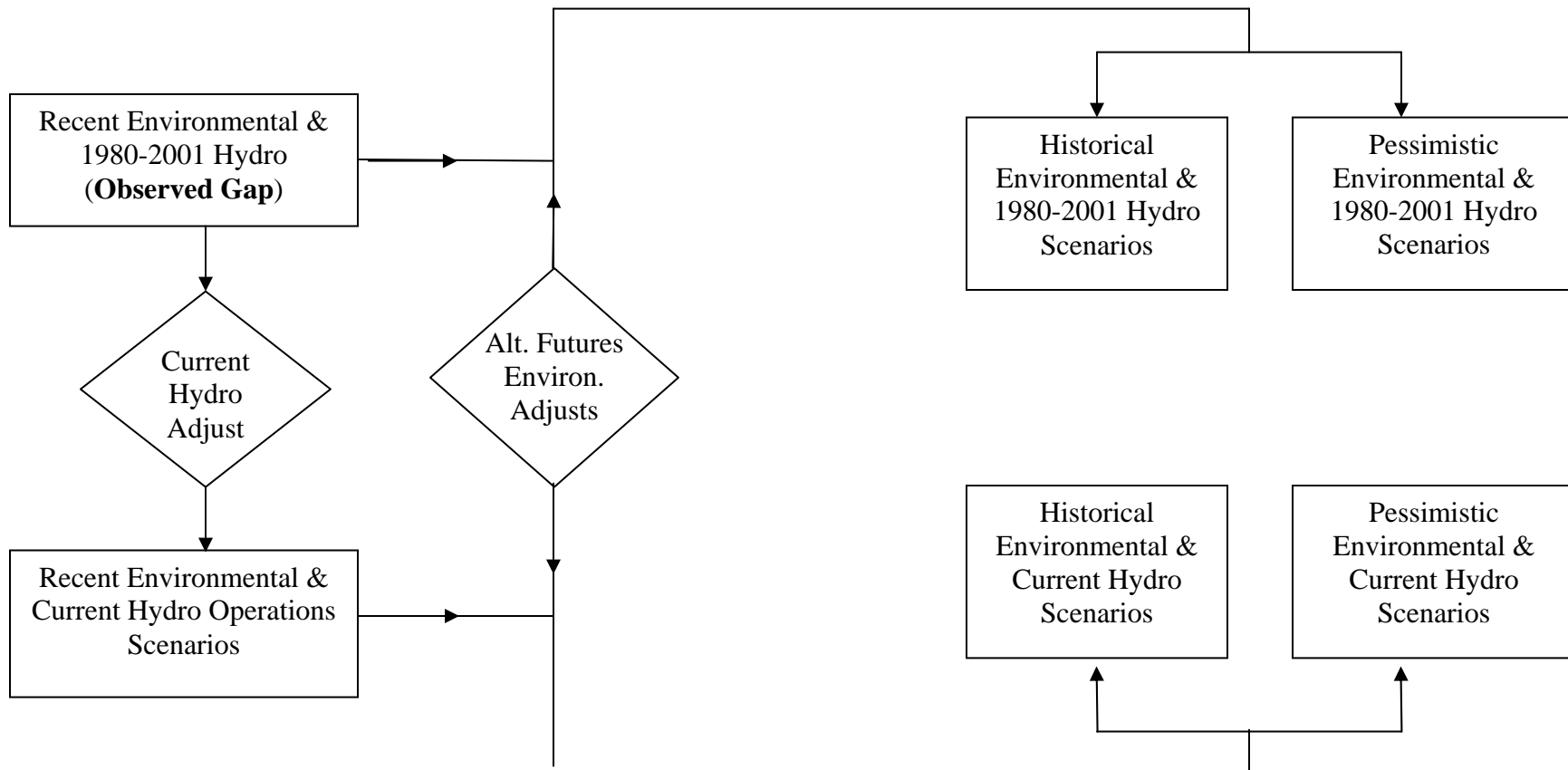


Figure 2. Flow chart demonstrating the adjustments to the Observed Gap, to represent scenarios generated by different combinations of hydropower operational and future environmental scenarios (see text for description of alternatives). All boxes represent entries in the accompanying tables. Diamonds represent model based adjustments.

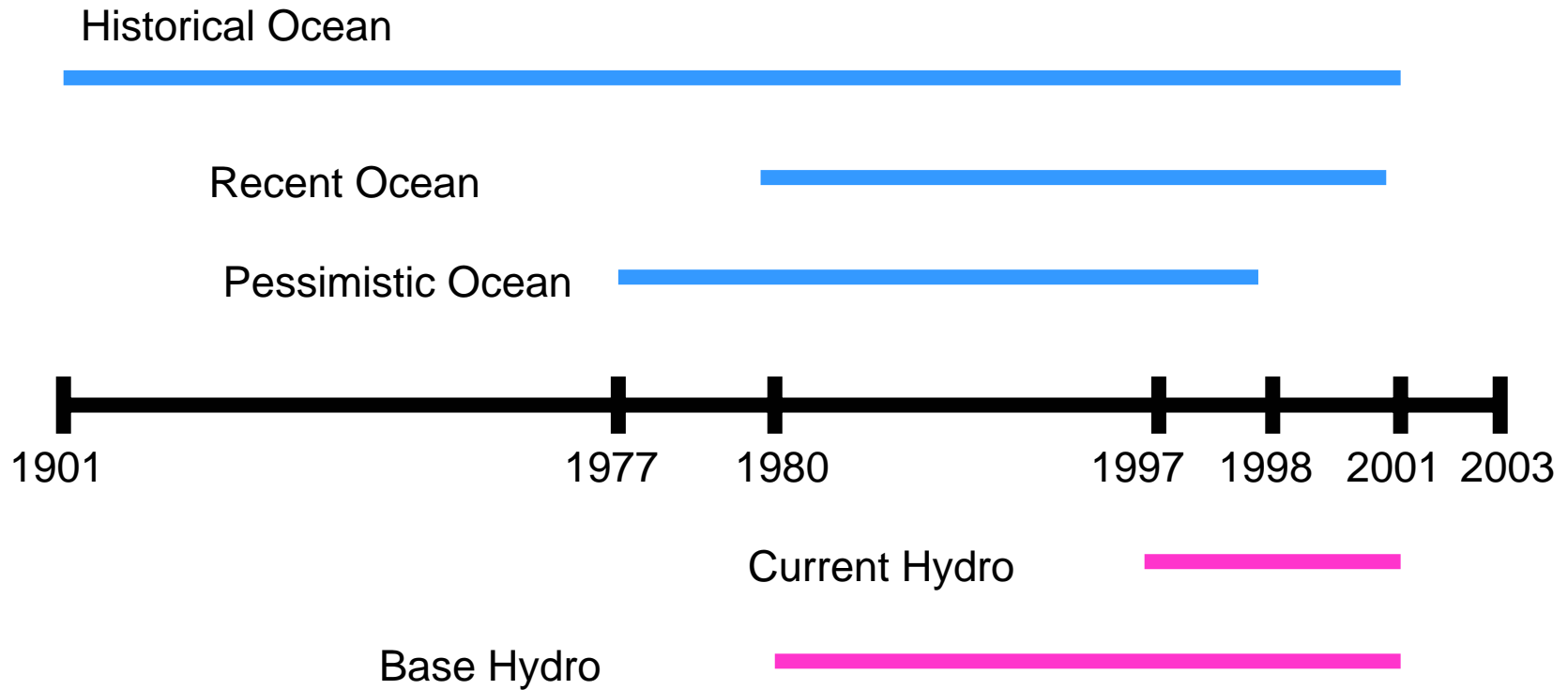


Figure 3. Timeline (not to scale) showing years/conditions incorporated into each early ocean survival and hydro scenario presented in this memo.

### **ESU Viability**

The “gaps” shown in the attached tables reflect the level of improvement in survivals across the life cycle needed to return a particular population to a level of abundance and productivity the TRT associates with abundance and productivity goals for viability given the corresponding assumption regarding future climate conditions. Under the ESU level viability criteria developed by the ICTRT approximately one-half of the populations within each major population grouping must, at a minimum, exhibit less than a 5% extinction risk. Therefore not all population survival gaps need to be completely filled in order for an ESU to be considered to have reached recovery.

National Marine Fisheries Service (NOAA Fisheries) advises that these tables do not constitute a legal determination of the status of these ESUs or an opinion about the effect of particular actions under the Endangered Species Act.

### **Achieving biological viability criteria -- general conclusions**

- Increases in population productivity required to meet viability criteria vary with
  - ESU and population
  - Early ocean survival patterns
  - Level of risk (e.g. 1% or 5% extinction risk)
- Survival increases required to meet the 1% risk level criteria would need to be approximately 1.3 to 1.5 times higher relative to the increases required to achieve the 5% criteria.
- Survivals under current hydropower operations are improved relative to the average levels affecting the returns used in calculating recent average abundance and productivity levels (see details in companion document).
- For most populations, improving hydropower survival to levels anticipated by 2014 in the 2004 Biological Opinion will mitigate risk (reduce the total required change), but will not be sufficient to meet viability criteria (projected improvements in hydropower survival is approximately 2% for Snake River spring/summer Chinook and 10% for Upper Columbia spring chinook).
- Early ocean survival is a strong determinant of overall productivity; thus any factor affecting survival at that stage, including prolonged periods of poor ocean conditions, estuarine or plume conditions, or latent mortality attributable to the hydropower system have the potential to change the overall required survival change substantially.
- Current abundance levels for populations in the Snake River and Upper Columbia chinook ESUs are well below the minimum thresholds defined in the ICTRT viability criteria (Tables 2a, 3a). Addressing the deficits in population specific productivity levels identified in the accompanying tables will contribute to rebuilding. Actually achieving abundance and productivity criteria will require a sustained and significant response by the populations.
- The ICTRT has developed alternative methods for buffering against high levels of uncertainty in population abundance and productivity estimates. We used a second

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risk test<sup>1</sup> to determine alternative adjusted gap estimates for those populations with sufficiently high productivity standard errors. The second risk test was designed to reduce the probability that the actual population risk was greater than 25% in 100 years to less than 1 in 20 (at 5% risk) and 1 in 100 (1% risk).

Because data available to support this analysis varied from ESU to ESU, and in some cases from population to population, we present a summary of ESU-specific methods and results below, in the following order:

- SNAKE RIVER spring/summer chinook
- UPPER COLUMBIA spring chinook
- SNAKE RIVER fall chinook
- MID COLUMBIA steelhead
- SNAKE RIVER steelhead
- UPPER COLUMBIA steelhead

The section for each ESU contains a brief narrative summarizing the availability of population specific abundance and productivity data along with results of the Observed and Projected A/P Gaps analyses. Those results are described in the context of ICTRT ESU and Major Population Grouping level viability criteria. We also provide a comparative summary of median and range of the estimated A/P Gaps within each listed Upper Columbia River ESU in Table 1.

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<sup>1</sup> Method B1 as described in ICTRT Dec. 2005 Viability Update Memo

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Table 1. Survival change necessary to meet IC-TRT abundance and productivity viability goals under alternate scenarios, summarized by ESU. Median values are presented in each cell, with the range in parentheses.

Scenario	Snake River Spring/Summer Chinook	Upper Columbia Spring Chinook	Snake River Fall Chinook	Middle Columbia Steelhead	Snake River Steelhead	Upper Columbia Steelhead
<b>Observed (25%)</b>	0.14 (0.01, 1.94)	0.82 (0.58, 0.90)	0.18 (0.00, 0.37)	0.00 (0.00, 0.17)	0.00 (0.00, 0.12)	4.07 (2.57, 5.94)
<b>Observed (5%)</b>	0.88 (0.21, 2.97)	1.35 (0.98, 1.56)	0.30 (0.04, 0.56)	0.21 (-0.47, 1.01)	0.00 (-0.59, 0.65)	5.57 (3.33, 7.69)
<b>Observed (1%)</b>	1.50 (0.49, 4.14)	2.31 (1.78, 2.23)	0.52 (0.83, 0.21)	0.21 (-0.37, 1.01)	0.03 (-0.54, 0.65)	7.28 (4.13, 9.44)
<b>Projected Gap (5%) Under Recent Ocean (same as observed above)</b>						
<b>PDO Index Model</b>						
<b>Observed</b>	0.88 (0.21, 2.97)	1.35 (0.98, 1.56)	xx (xx, xx)	0.21 (-0.47, 1.01)	0.00 (-0.59, 0.65)	5.57 (3.33, 7.69)
<b>Hydro Adjusted</b>	0.68 (0.08, 2.55)	1.01 (0.69, 1.18)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	4.62 (2.70, 6.43)
<b>Multiple Index Model</b>						
<b>Observed</b>	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)
<b>Hydro Adjusted</b>	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)
<b>Explicit Delayed Effects Model</b>						
<b>Observed</b>	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)
<b>Hydro Adjusted</b>	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)
<b>Projected Gap (5%) Under Historical Ocean</b>						
<b>PDO Index Model</b>						
<b>Observed</b>	0.45 (-0.07, 2.06)	0.79 (0.51, 0.95)	xx (xx, xx)	-0.07 (-0.59, 0.53)	-0.23 (-0.23, -0.14)	4.02 (2.31, 5.63)
<b>Hydro Adjusted</b>	0.29 (-0.17, 1.73)	0.53 (0.29, 0.67)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	3.29 (1.83, 4.67)
<b>Multiple Index Model</b>						
<b>Observed</b>	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)
<b>Hydro Adjusted</b>	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)
<b>Explicit Delayed Effects Model</b>						
<b>Observed</b>	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)

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Scenario	Snake River Spring/Summer Chinook	Upper Columbia Spring Chinook	Snake River Fall Chinook	Middle Columbia Steelhead	Snake River Steelhead	Upper Columbia Steelhead
<b>Hydro Adjusted</b>	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)
<b>Projected Gap (5%) Under Pessimistic Ocean</b>						
<b>PDO Index Model</b>						
<b>Observed</b>	1.24 (0.44, 3.73)	1.87 (1.41, 2.12)	xx (xx, xx)	0.48 (-0.35, 1.45)	0.19 (0.19, 0.33)	7.02 (4.28, 9.59)
<b>Hydro Adjusted</b>	1.00 (0.29, 3.22)	1.56 (1.15, 1.78)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	6.16 (3.72, 8.46)
<b>Multiple Index Model</b>						
<b>Observed</b>	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)
<b>Hydro Adjusted</b>	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)
<b>Explicit Delayed Effects Model</b>						
<b>Observed</b>	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)
<b>Hydro Adjusted</b>	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)	xx (xx, xx)

## Population Survival Gaps

### **Snake River Spring/Summer Chinook ESU**

Population specific current abundance/productivity estimates, status ratings and Observed A/P Gaps results are summarized in Table 2a. Recent Hydro Adjusted A/P Gaps and Projected A/P Gaps results relative to 25%, 5% and 1% viability curves are summarized in Table 2b.

#### Summary by Major Population Grouping

The following summaries, organized by Major Population Grouping (MPG), describe the Observed Gaps and the range in resulting Projected Gaps for Snake River Spring/Summer Chinook populations. Results of the A/P Gap analyses are provided in Tables 2a and 2b. The MPG summaries include the all population MPG median A/P Gap estimates from the Observed Gap analysis and for the most optimistic optimistic Projected Gap scenario analyzed, the 100 year Ocean (PDO Index) combined with Recent Hydro Adjusted. Each MPG narrative also highlights the range in population level A/P gaps for a minimum set corresponding to meeting ICTRT MPG level viability criteria.

Lower Snake MPG The Tucannon River population is the only extant population in this grouping. A 0.55 increase in average survival would be required to meet the 5% risk criteria for the Observed Gap. Exceeding the 1% risk curve from the Observed Gap would require a 0.94 improvement in cumulative life cycle survival.

At the 5% risk level, the Projected A/P Gap under the Historical Ocean/Recent Hydro scenario was 0.07. Under this scenario for the 1% risk level, the Projected A/P Gap was 0.33.

Grande Ronde/Imnaha MPG Six of the eight historical populations in this grouping are considered extant, the median Observed A/P Gap (relative to the 5% viability curve) is 1.01. Four populations must exceed the 5% risk curve to meet ICTRT MPG objectives. Several combinations of viable individual populations could meet the ICTRT criteria, the set with the lowest gaps would include: Minam R. (0.55), Imnaha R. (0.88), Lostine R. (0.88) and Catherine Creek (2.16). The Minam River population would require the least improvement in survival to achieve High Viability (1% risk curve) with an Observed Gap of 1.06.

The median Projected A/P Gap under the Historical Ocean/Recent Hydro scenario was 0.38. The range in Projected A/P gaps for the MPG populations described above under the Historical Ocean/Recent Hydro scenario would be 0.06 to 1.73. The Minam River population gap relative to the 1% risk criteria under this scenario would be 0.41.

South Fork Salmon MPG All three of the historical populations in this region are extant and two must meet viability criteria for the MPG to be considered at low risk. The median Observed A/P Gap (relative to the 5% viability curve) is 0.52. ICTRT criteria

call for two populations from this group exceeding the 5% risk curve, with one of those achieving the 1% risk level. The Observed Gap relative to the 5% risk level ranged from 0.50 (East Fork Johnson Creek) to 0.59 (the South Fork Mainstem population). The East Fork Johnson Creek population would require the least improvement in survival to achieve High Viability (1% risk curve) with an Observed Gap of 0.90.

The median Projected A/P Gap under the Historical Ocean/Recent Hydro scenario was 0.04. The range in Projected A/P gaps for the MPG populations described above under the Historical Ocean/Recent Hydro scenario would be 0.03 to 0.09. Under this scenario, the East Fork Johnson Creek population is projected to achieve the 1% risk curve with a survival improvement of 0.30.

*Middle Fork Salmon MPG* All nine of the historical populations in this MPG are currently extant, five would need to meet or exceed the ICTRT viability criteria. The median baseline gap (5% risk curve/threshold) for this grouping is 1.03. Several combinations of viable individual populations could meet the ICTRT criteria, the set with the lowest gaps would include: Bear Valley (0.26), Big Creek (0.65), Camas Creek (1.03), Marsh Creek (1.18 ). The data set for Chamberlain Creek indicates relatively high productivity, missing years in the series resulted in insufficient data for specifically calculating gaps. The Bear Valley population exhibited the lowest baseline gap relative to the 1% risk criteria (0.54).

The median Projected A/P Gap under the Historical Ocean/Recent Hydro scenario was 0.40. The range in Projected A/P gaps for the MPG populations described above under the Historical Ocean/Recent Hydro scenario would be -0.13 to 0.50. Under this scenario, the Bear Valley population would project to achieve the 1% risk curve with a survival improvement of 0.06.

*Upper Salmon MPG* Eight of the nine historical populations in this MPG are currently extant. A minimum of five would need to meet or exceed the ICTRT viability criteria. The median Observed A/P Gap (relative to the 5% viability curve) is 0.96. The minimum set of populations to meet ICTRT MPG criteria would include: Valley Creek (0.96), Upper Salmon River (0.49), East Fork Salmon River (0.21), Pahsimeroi River (2.49) and Lemhi River (0.60). The Upper Salmon River population exhibited the lowest baseline gap relative to the 1% risk criteria (0.49).

The median Projected A/P Gap under the Historical Ocean/Recent Hydro scenario was 0.35. The range in Projected A/P gaps for the MPG populations described above under the Historical Ocean/Recent Hydro scenario would be -0.17 to 1.59. Under this scenario, the East Fork Johnson Creek population would project to achieve the 1% risk curve with a survival improvement of 0.08.

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Table 2a. **SNAKE RIVER SPRING/SUMMER CHINOOK ESU**. Population level statistics and Observed Gaps. ICTRT ratings for A&P (Abundance and Productivity) and SSD (Spatial Structure and Diversity). Current risk assessment results (H = high risk, M= moderate risk, L = low risk, VL = very low risk).

Population	Threshold	10-year Geomean abund.	Abund. Range	10-yr Hatchery Fraction	Productivity	Productivity SE	A&P Rating	SSD Rating	1978-2004 Harvest Rate	Observed Gaps			Relative Uncertainty Adjustment	
										25%	5%	1%	Adjusted 5% Gap	Adjusted 1% Gap
<b>SR Spring/Summer Chinook</b>														
Tucannon River	750	177	47-741	53%	1.25	0.17	H	H	0.08	0.05	0.55	0.94		
Asotin Creek	500	Functionally Extirpated												
Catherine Creek	750	80	34-415	29%	0.50	0.23	H	M	0.08	1.12	2.16	3.20	2.21	
Lostine River	1000	266	85-492	28%	0.76	0.22	H	M	0.08	0.45	0.88	1.43	0.94	
Minam River	750	337	145-583	4%	1.02	0.21	H	M	0.08	0.12	0.55	1.06	0.56	
Imnaha River	750	395	2357	65%	0.84	0.12	H	M	0.08	0.30	0.88	1.50		
Wenaha River	750	376	68-750	5%	0.74	0.19	H	M	0.08	0.45	1.14	1.84		
Upper Grande Ronde	1000	40	4-200	23%	0.36	0.25	H	H	0.08	1.94	2.97	4.14	3.08	4.20
Big Sheep Creek <sup>a</sup>	500	4	0-170	38%	0.29	0.44	H	H	0.08					
Lookingglass Creek	500	Functionally Extirpated												
South Fork Mainstem	1000	556	167-2495	38%	0.90	0.17	H	M	0.08	0.20	0.59	1.06		
Secesh River	750	304	69-1097	4%	1.04	0.13	H	L	0.08	0.10	0.52	1.02		
East Fork Johnson	1000	321	56-1593	10%	1.03	0.21	H	L	0.08	0.11	0.50	0.90		
Little Salmon River	500	Insufficient Data												
Big Creek	1000	94	5-690	0%	1.25	0.20	H	M	0.08	0.06	0.65	0.95		
Bear Valley Creek	750	188	16-1264	0%	1.47	0.18	H	L	0.08	0.01	0.26	0.54		
Marsh Creek	500	42	0-605	0%	1.05	0.21	H	L	0.08	0.14	1.18	2.44		
Sulphur Creek	500	21	1-178	0%	0.92	0.36	H	M	0.08	0.24	1.03	2.37	1.24	2.40
Camas Creek	500	29	0-269	0%	0.92	0.29	H	M	0.08	0.24	1.03	2.37	1.14	
Loon Creek	500	51	2-635	0%	1.15	0.31	H	M	0.08	0.10	1.13	2.31		
Chamberlain Creek	500	Insufficient Data												
Lower Middle Fork Salmon	500	Insufficient Data												
Upper Middle Fork Salmon	750	Insufficient Data												
Lemhi River	2000	80	10-606	0%	1.08	0.26	H	L	0.08	0.13	0.60	0.81		
Valley Creek	500	35	0-302	0%	1.08	0.24	H	H	0.08	0.14	0.96	2.14		
Yankee Fork	500	13	0-161	0%	0.80	0.31	H	H	0.08	0.43	1.34	2.88	1.48	
Upper Salmon River	1000	268	95-767	25%	1.47	0.21	H	M	0.08	0.01	0.49	0.49		
North Fork Salmon River	500	Insufficient Data												
Lower Salmon River	2000	123	44-449	0%	1.25	0.18	H	L	0.08	0.05	2.77	2.77		
East Fork Salmon River	1000	169	10-891	8%	1.18	0.25	H	H	0.08	0.08	0.21	0.57	0.32	0.62
Pahsimeroi River	1000	112	49-328	42%	0.41	0.39	H	H	0.08	1.59	2.49	3.51	2.79	3.86
Panther Creek	750	Functionally Extirpated												

- Big Sheep Population (Imnaha River). Viability data are presented, however population is considered functionally extinct.
- Relative Uncertainty Adjustment: If no value presented, adjusted gap is less than Observed Gap.

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Table 2b. **SNAKE RIVER SPRING/SUMMER CHINOOK ESU.** Required change in survival projected to meet abundance and productivity criteria for 25%,5% and 1% Risk Curves under a range of ocean/hydropower survival scenarios. Projected A/P Gap is the survival improvement projected as necessary to meet a particular risk criteria after accounting for survival adjustment. average hydropower and harvest survival levels. Gap estimates are expressed as a proportion of current survival. A gap of 0.5 requires increasing average life cycle survivals by 50% (multiplying by 1.5) over recent average.

SR Spring/Summer Chinook	Estimated Abundance/Productivity Gap Scenarios ( 25% Risk Curve)																	
	Recent Ocean Survival						Historical Ocean Survival						Pessimistic Ocean Survival					
	PDO Model		PDO/WTT/UPW Model		Explicit Delayed Mortality Model		PDO Model		PDO/WTT/UPW Model		Explicit Delayed Mortality Model		PDO Model		PDO/WTT/UPW Model		Explicit Delayed Mortality Model	
	Base Hydro	Current Hydro	Base Hydro	Current Hydro	Base Hydro	Current Hydro	Base Hydro	Current Hydro	Base Hydro	Current Hydro	Base Hydro	Current Hydro	Base Hydro	Current Hydro	Base Hydro	Current Hydro	Base Hydro	Current Hydro
<b>Lower Snake</b>																		
Tucannon River	0.05	-0.06					-0.19	-0.28					0.25	0.11				
Asotin Creek																		
<b>Grande Ronde / Imnaha</b>																		
Catherine Creek	1.12	0.89					0.63	0.46					1.52	1.25				
Lostine River	0.45	0.29					0.11	-0.01					0.72	0.54				
Minam River	0.12	0.00					-0.14	-0.23					0.33	0.19				
Imnaha River	0.30	0.16					0.00	-0.11					0.54	0.38				
Wenaha River	0.45	0.29					0.11	-0.01					0.72	0.54				
Upper Grande Ronde	1.94	1.63					1.26	1.02					2.51	2.13				
Big Sheep Creek																		
Lookingglass Creek																		
<b>South Fork Salmon</b>																		
South Fork Mainstem	0.20	0.07					-0.08	-0.18					0.43	0.28				
Secesh River	0.10	-0.02					-0.16	-0.25					0.30	0.17				
East Fork Johnson	0.11	-0.01					-0.15	-0.24					0.32	0.18				
Little Salmon River																		
<b>Middle Fork Salmon</b>																		
Big Creek	0.06	-0.06					-0.19	-0.27					0.26	0.12				
Bear Valley Creek	0.01	-0.09					-0.22	-0.30					0.21	0.08				
Marsh Creek	0.14	0.02					-0.12	-0.22					0.36	0.21				
Sulphur Creek	0.24	0.11					-0.05	-0.15					0.48	0.32				
Camas Creek	0.24	0.11					-0.05	-0.15					0.48	0.32				
Loon Creek	0.10	-0.01					-0.15	-0.24					0.31	0.17				
Chamberlain Creek	0.01	-0.10					-0.22	-0.31					0.20	0.07				
Lower Middle Fork Salmon																		
Upper Middle Fork Salmon																		
<b>Upper Salmon</b>																		
Lemhi River																		
Lemhi River - 2	0.13	0.01					-0.13	-0.22					0.34	0.20				
Valley Creek	0.14	0.02					-0.12	-0.22					0.36	0.21				
Yankee Fork	0.43	0.27					0.10	-0.02					0.70	0.51				
Upper Salmon River	0.01	-0.10					-0.23	-0.31					0.20	0.07				
North Fork Salmon River																		
Lower Salmon River	0.05	-0.06					-0.19	-0.28					0.25	0.11				
East Fork Salmon River	0.08	-0.04					-0.17	-0.26					0.28	0.14				
Pahsimeroi River	1.59	1.31					0.99	0.78					2.08	1.75				
Panther Creek																		

# Interim ICTRT Gaps Report

Table 2b. (Continued)

SR Spring/Summer Chinook	Estimated Abundance/Productivity Gap Scenarios ( 5% Risk Curve)																	
	Recent Ocean Survival						Historical Ocean Survival						Pessimistic Ocean Survival					
	PDO Model		PDO/WTT/UPW Model		Explicit Delayed Mortality Model		PDO Model		PDO/WTT/UPW Model		Explicit Delayed Mortality Model		PDO Model		PDO/WTT/UPW Model		Explicit Delayed Mortality Model	
	Base Hydro	Current Hydro	Base Hydro	Current Hydro	Base Hydro	Current Hydro	Base Hydro	Current Hydro	Base Hydro	Current Hydro	Base Hydro	Current Hydro	Base Hydro	Current Hydro	Base Hydro	Current Hydro	Base Hydro	Current Hydro
<b>Lower Snake</b>																		
Tucannon River	0.55	0.39					0.19	0.07					0.85	0.65				
Asotin Creek																		
<b>Grande Ronde / Imnaha</b>																		
Catherine Creek	2.16	1.82					1.43	1.17					2.76	2.36				
Lostine River	0.88	0.68					0.45	0.29					1.24	1.00				
Minam River	0.55	0.38					0.19	0.06					0.84	0.65				
Imnaha River	0.88	0.68					0.45	0.29					1.24	1.00				
Wenaha River	1.14	0.91					0.64	0.47					1.54	1.27				
Upper Grande Ronde	2.97	2.55					2.06	1.73					3.73	3.22				
Big Sheep Creeka																		
Lookingglass Creek																		
<b>South Fork Salmon</b>																		
South Fork Mainstem	0.59	0.42					0.22	0.09					0.89	0.69				
Secesh River	0.52	0.36					0.17	0.04					0.81	0.61				
East Fork Johnson	0.50	0.34					0.16	0.03					0.79	0.60				
Little Salmon River																		
<b>Middle Fork Salmon</b>																		
Big Creek	0.65	0.47					0.27	0.13					0.96	0.75				
Bear Valley Creek	0.26	0.13					-0.03	-0.13					0.50	0.34				
Marsh Creek	1.18	0.95					0.68	0.50					1.59	1.32				
Sulphur Creek	1.03	0.81					0.56	0.40					1.42	1.16				
Camas Creek	1.03	0.81					0.56	0.40					1.42	1.16				
Loon Creek	1.13	0.91					0.64	0.47					1.54	1.27				
Chamberlain Creek																		
Lower Middle Fork Salmon																		
Upper Middle Fork Salmon																		
<b>Upper Salmon</b>																		
Lemhi River	0.60	0.43					0.23	0.10					0.90	0.70				
Valley Creek	0.96	0.75					0.51	0.35					1.34	1.09				
Yankee Fork	1.34	1.09					0.80	0.61					1.78	1.48				
Upper Salmon River	0.49	0.33					0.15	0.02					0.78	0.59				
North Fork Salmon River																		
Lower Salmon River	2.77	2.37					1.90	1.59					3.49	3.01				
East Fork Salmon River	0.21	0.08					-0.07	-0.17					0.44	0.29				
Pahsimeroi River	2.49	2.11					1.68	1.40					3.15	2.71				
Panther Creek																		

# Interim ICTRT Gaps Report

Table 2b. (Continued)

SR Spring/Summer Chinook	Estimated Abundance/Productivity Gap Scenarios ( 1% Risk Curve)																	
	Recent Ocean Survival						Historical Ocean Survival						Pessimistic Ocean Survival					
	PDO Model		PDO/WTT/UPW Model		Explicit Delayed Mortality Model		PDO Model		PDO/WTT/UPW Model		Explicit Delayed Mortality Model		PDO Model		PDO/WTT/UPW Model		Explicit Delayed Mortality Model	
	Base Hydro	Current Hydro	Base Hydro	Current Hydro	Base Hydro	Current Hydro	Base Hydro	Current Hydro	Base Hydro	Current Hydro	Base Hydro	Current Hydro	Base Hydro	Current Hydro	Base Hydro	Current Hydro	Base Hydro	Current Hydro
<b>Lower Snake</b>																		
Tucannon River	0.94	0.73					0.49	0.33					1.31	1.06				
Asotin Creek																		
<b>Grande Ronde / Imnaha</b>																		
Catherine Creek	3.20	2.75					2.23	1.88					4.00	3.46				
Lostine River	1.43	1.17					0.87	0.67					1.90	1.59				
Minam River	1.06	0.84					0.58	0.41					1.45	1.19				
Imnaha River	1.50	1.23					0.92	0.72					1.98	1.66				
Wenaha River	1.84	1.53					1.18	0.95					2.38	2.02				
Upper Grande Ronde	4.14	3.59					2.95	2.53					5.12	4.46				
Big Sheep Creeka																		
Lookingglass Creek																		
<b>South Fork Salmon</b>																		
South Fork Mainstem	1.06	0.84					0.58	0.41					1.45	1.18				
Secesh River	1.02	0.80					0.55	0.39					1.40	1.15				
East Fork Johnson	0.90	0.69					0.46	0.30					1.26	1.02				
Little Salmon River																		
<b>Middle Fork Salmon</b>																		
Big Creek	0.95	0.74					0.50	0.34					1.32	1.07				
Bear Valley Creek	0.54	0.38					0.19	0.06					0.84	0.64				
Marsh Creek	2.44	2.07					1.65	1.36					3.10	2.66				
Sulphur Creek	2.37	2.01					1.59	1.31					3.01	2.58				
Camas Creek	2.37	2.01					1.59	1.31					3.01	2.58				
Loon Creek	2.31	1.95					1.55	1.27					2.94	2.52				
Chamberlain Creek																		
Lower Middle Fork Salmon																		
Upper Middle Fork Salmon																		
<b>Upper Salmon</b>																		
Lemhi River	0.81	0.62					0.40	0.25					1.16	0.93				
Valley Creek	2.14	1.80					1.41	1.16					2.74	2.34				
Yankee Fork	2.88	2.46					1.98	1.66					3.61	3.12				
Upper Salmon River	0.49	0.33					0.15	0.02					0.78	0.59				
North Fork Salmon River																		
Lower Salmon River	2.77	2.37					1.90	1.59					3.49	3.01				
East Fork Salmon River	0.57	0.40					0.21	0.08					0.87	0.67				
Pahsimeroi River	3.51	3.03					2.47	2.10					4.37	3.80				
Panther Creek																		

Upper Grand Ronde and Catherine Creek substantially reduced from historical capacity.

Lostine/Wallowa may require increase in functional spawning/rearing capacity to meet abundance threshold in combination with the survival improvements indicated in this analysis.

Chamberlain Creek; Trend data with missing years, increased escapements in recent years

<sup>1</sup> Lemhi and Pahsimeroi are substantially reduced from historical capacity. Lemhi productivity gap analysis extremely sensitive to current capacity estimate. 1) includes assumption capacity is at 1950/60s level. 2) gap if capacities remain at levels indicated by current analysis.

Data sets insufficient for productivity/abundance assessments for North Fork Salmon River population. Gaps for these likely at mid to high end of range for Upper Salmon populations.

### **Upper Columbia Spring Chinook ESU**

This ESU is currently limited to three extant populations in one Major Population Grouping. The MPG supported a fourth population in the Okanogan River basin, it is functionally extinct. Two additional MPGs likely existed, the tributaries that supported them are now cut off from anadromous access by Grand Coulee and Chief Joseph Dams. The median base period gap (5% risk curve) for the three extant populations in this ESU is 1.35 (Wenatchee), ranging from 0.98 (Methow) to 1.56 (Entiat). The ICTRT has recommended that two populations from this group be targeted for very low risk to compensate, in part, for the loss of the upriver populations in this ESU. The baseline gaps relative to a 1% risk curve for the Wenatchee and the Methow are 2.31 and 1.78, respectively.

Under the 100 year ocean scenario and assuming recent average hydropower system related survivals continue, the median 5% risk gap would decrease to 0.53 (0.29 to 0.67). The gaps relative to the 1% risk curve under this scenario would be 1.16 and 0.82 for the Wenatchee and Methow populations, respectively.

## Interim ICTRT Gaps Report

Table 3a. **UPPER COLUMBIA SPRING CHINOOK ESU.** Population level statistics and Observed Gaps. ICTRT ratings for A&P (Abundance and Productivity) and SSD (Spatial Structure and Diversity). Current risk assessment results (H = high risk, M= moderate risk, L = low risk, VL = very low risk).

Population	Threshold	10-year Geomean abund.	Abund. Range	10-yr Hatchery Fraction	Productivity	Productivity SE	A&P Rating	SSD Rating	1978-2004 Harvest Rate	Observed Gaps			Relative Uncertainty Adjustment	
										25%	5%	1%	Adjusted 5% Gap	Adjusted 1% Gap
<b>Upper Columbia Chinook</b>														
Wenatchee	2000	226	18-1798	38%	0.74	0.31	H	H	0.08	0.82	1.35	2.31		
Methow	2000	205	30-1870	48%	0.88	0.22	H	H	0.08	0.58	0.98	1.78		
Entiat	500	63	12-312	131%	0.72	0.15	H	H	1.08	0.90	1.56	2.33		

a. Relative Uncertainty Adjustment: If no value presented, adjusted gap is less than Observed Gap.

## Interim ICTRT Gaps Report

Table 3b. **UPPER COLUMBIA SPRING CHINOOK ESU**. Required change in survival projected to meet abundance and productivity criteria. Gap estimates are expressed as a proportion of current survival. A gap of 0.5 requires increasing average life cycle survivals by 50% (multiplying by 1.5) over recent average levels.

Upper Columbia Chinook  Populations	Estimated Abundance/Productivity Gap Scenarios ( 25% Risk Curve)																	
	Recent Ocean Survival						Historical Ocean Survival						Pessimistic Ocean Survival					
	PDO Model		PDO/WTT/UPW Model		Explicit Delayed Mortality Model		PDO Model		PDO/WTT/UPW Model		Explicit Delayed Mortality Model		PDO Model		PDO/WTT/UPW Model		Explicit Delayed Mortality Model	
	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro
Upper Columbia Chinook																		
Wenatchee	0.82	0.56					0.39	0.19					1.22	0.99				
Methow	0.58	0.35					0.21	0.03					0.93	0.72				
Entiat	0.90	0.63					0.45	0.24					1.32	1.07				

Upper Columbia Chinook  Populations	Estimated Abundance/Productivity Gap Scenarios ( 5% Risk Curve)																	
	Recent Ocean Survival						Historical Ocean Survival						Pessimistic Ocean Survival					
	PDO Model		PDO/WTT/UPW Model		Explicit Delayed Mortality Model		PDO Model		PDO/WTT/UPW Model		Explicit Delayed Mortality Model		PDO Model		PDO/WTT/UPW Model		Explicit Delayed Mortality Model	
	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro
Upper Columbia Chinook																		
Wenatchee	1.35	1.01					0.79	0.53					1.87	1.56				
Methow	0.98	0.69					0.51	0.29					1.41	1.15				
Entiat	1.56	1.18					0.95	0.67					2.12	1.78				

Upper Columbia Chinook  Populations	Estimated Abundance/Productivity Gap Scenarios ( 1% Risk Curve)																	
	Recent Ocean Survival						Historical Ocean Survival						Pessimistic Ocean Survival					
	PDO Model		PDO/WTT/UPW Model		Explicit Delayed Mortality Model		PDO Model		PDO/WTT/UPW Model		Explicit Delayed Mortality Model		PDO Model		PDO/WTT/UPW Model		Explicit Delayed Mortality Model	
	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro
Upper Columbia Chinook																		
Wenatchee	2.31	1.83					1.53	1.16					3.04	2.60				
Methow	1.78	1.38					1.13	0.82					2.40	2.03				
Entiat	2.33	1.85					1.54	1.17					3.07	2.63				

## **Snake River Fall Chinook ESU**

The ICTRT has concluded that the Snake River drainage historically supported three populations of fall chinook. At present, only one of the three historical populations is extant (mainstem and tributaries below Hells Canyon). The extirpated mainstem populations above the Hells Canyon dam complex were relatively large and productive, dominating production for this ESU. The following gaps analysis focuses on productivity and abundance of the extant population. Re-establishing natural production in the historical core production areas above the Hells Canyon complex would substantially reduce risks to the long-term persistence of this ESU.

### Considerations

A number of factors had the potential to significantly influence return rates during the period examined including:

- The relatively short time series of representative data,
- Lack of a demonstrated surrogate for tracking annual variations in ocean survival,
- Changes in ocean and in-river exploitation rates over time and significant changes in hydropower/transportation over the past 10-15 years.
- The increasing presence of multiple life history patterns (Connor, et al. 2005).

*Downstream passage survival:* Available data clearly indicates that the hydropower system has a major affect on migration and rearing survivals for Snake River fall chinook. At this point we do not have a model for use in partitioning out downstream passage mortalities for Snake River fall chinook. Contributing factors include: the lack of a complete and consistent measure of outmigrating smolts over a substantial period of years, the potential influence of the significant changes in hydropower operations since the listing in the early 1990s, and the increasing presence of multiple life history patterns in fall chinook (Connor, et al. 2005). We are continuing to explore the use of available data sets in simple life cycle and passage models for application to Snake River fall chinook.

*Year to Year Fluctuations in Ocean Survival:* At this time, a direct SAR series representative of naturally produced Snake River fall chinook is not available.

*Harvest:* We used estimated annual exploitation rates generated by the Columbia River Technical Advisory Committee (TAC) as the basis for a harvest rate index.

### *Current Productivity and Abundance*

We analyzed two time series, brood years 1977-1999 brood and 1990-99. By definition the longer series captures more of the potential year to year variations in survival rates, but it also bridges across two distinctly different sets of in-river conditions and hydropower operations. The more recent period (1990-99) corresponds to a period of relatively consistent harvest and hydropower operations with reduced impacts on Snake River fall chinook. It is difficult to separate variations in ocean survivals from potential changes in hydropower impacts without comparative measures of juvenile passage survivals under current operations or a representative measure of ocean survival rates. At this time, it is reasonable to assume that the current A/P Gap falls within the range defined by the two recent scenarios (0.01 to 0.28 relative to the 5% risk curve, 0.07 to 0.47 at the 1% risk level).

## Interim ICTRT Gaps Report

Table 4a. **SNAKE RIVER FALL CHINOOK ESU**. Required change in survival projected to meet abundance/productivity criteria. No direct SAR or hydropower survival time series. Gap estimates are expressed as a proportion of life stage survivals, and are based on a 1977 to 2004 data series. Two alternative scenarios were used in the assessment of this population: “Baseline” (averages over the 1977-99 brood year returns), and “Recent” (averages over the 1990-99 brood year returns). The recent period reflects improved transportation, flow and temperature patterns during rearing/migration period, increasing presence of reservoir resident form. Gap estimates for this population are **PRELIMINARY**.

Population	Threshold	10-year Geomean abund.	Abund. Range	10-yr Hatchery Fraction	Productivity	Productivity SE	A&P Rating	SSD Rating	1978-2004 Harvest Rate	Observed Gaps			Relative Uncertainty Adjustment	
										25%	5%	1%	Adjusted 5% Gap	Adjusted 1% Gap
<b>Snake River Fall Chinook</b>														
Fall Chinook (1977-1999)	3000	1273	306-5083	0.54	0.95	0.14	H			0.18	0.47	0.69		
Fall Chinook (1990-1999)	3000	1273	306-5083	0.54	1.29	0.15	M			0.00	0.38	0.38		

a. Relative Uncertainty Adjustment: If no value presented, adjusted gap is less than Observed Gap

### **Mid Columbia Steelhead ESU**

This ESU includes four MPGs, each with multiple extant populations. Relative population status varies widely across this ESU. In general, the populations in the Yakima MPG have the largest A/P gaps relative to TRT viability criteria. Several populations in this ESU have relatively high productivities but are falling short of meeting natural abundance criteria. Under the simple algebraic rules we used for estimating survival gaps, these populations are generally driven by achieving threshold abundance levels. The ICTRT is evaluating available information to determine if adjustment factors can be calculated for any recent changes in hydropower survival or for longer term ocean/climate impacts. The following summaries reflect results of the Observed Gap analyses.

Eastern Cascades MPG: This group of populations occupies drainages from the eastern slopes of the Cascade mountain range that enter the mainstem Columbia upstream from the Hood River. Five of the seven populations in this MPG are currently extant. Under ICTRT guidelines, four of the seven populations in this grouping need to meet low risk viability criteria, the remaining three extant populations must be maintained. The median survival gap (5% risk curve) for the populations in this group with sufficient information to generate productivity estimates is 0.60, ranging from -0.14 (Deschutes Eastside) to 0.75 (Deschutes Westside). Two extant populations in this MPG do not have sufficient data series to calculate abundance and productivity estimates - Klickitat and Rock Creek. Abundance estimates for the Klickitat can be inferred from fishery monitoring information and redd count data (for some years).

John Day Basin MPG: The ICTRT identified five population in this MPG, contained entirely within the John Day River basin. A minimum of three populations in the MPG must meet low risk viability criteria under the proposed ICTRT criteria. The median gap (relative to 5% risk curve) for this grouping is 0.21. The North Fork John Day population is the only steelhead population in the Interior Columbia basin that currently meets the ICTRT Very Low Risk criteria (exceeds 1% risk curve). The largest gaps in this grouping are associated with the South Fork (0.32) and the Upper Mainstem populations (0.21).

Umatilla/Walla Walla MPG: This grouping of three extant and one functionally extirpated populations occupies drainages entering the Columbia downstream of the confluence with the Snake River. Data series for the extant populations are relatively short, therefore gap estimates based on these series should be considered preliminary. The Umatilla (0.09) and Walla Walla mainstem (-0.01) are the closest to achieving the 1% risk level (very low risk).

Yakima River MPG: There are four extant populations in this MPG. The median gap relative to the 5% risk curve for this MPG is 0.59. Gaps range from 0.57 (Toppenish Creek) to over 1.00 (Upper Yakima). Two populations are required to meet low risk criteria for the ESU, the other two must be maintained. At a minimum this would require restoring Satus and Toppenish Creeks (gaps = 0.59 and 0.57 respectively).

**Projected Gaps:** We are developing a specific steelhead model and input datasets representative of Mid-Columbia steelhead populations for use in assessing alternative future ocean and hydro scenarios. When the model and input datasets are completed we will develop the projected A/P gap estimates.

Table 5a: **Mid Columbia Steelhead ESU**. Population level statistics and Observed Gaps. ICTRT ratings for A&P (Abundance and Productivity) and SSD (Spatial Structure and Diversity). Current risk assessment results (H = high risk, M= moderate risk, L = low risk, VL = very low risk).

Population	Threshold	10-year Geomean abund.	Abund. Range	10-yr Hatchery Fraction	Productivity	Productivity SE	A&P Rating	SSD Rating	1978-2004 Harvest Rate	Observed Gaps			Relative Uncertainty Adjustment	
										25%	5%	1%	Adjusted 5% Gap	Adjusted 1% Gap
<b>Middle Columbia Steelhead</b>														
Deschutes (westside)	1000	470	109-1317	0.26	1.47	0.14	M	M		0.00	0.75	0.75	0.09	0.50
Deschutes (eastside)	1000	1579	172-8509	0.39	1.51	0.31	M	M		0.00	-0.14	0.02		
Klickitat River	1500						M	M						
Fifteenmile Creek	1000	593	196-1922	0	2.03	0.22	M	L		0.00	0.60	0.60		
Rock Creek	500	Insufficient Data					H	M						
White Salmon	1000	Functionally Extirpated					N/A	N/A						
Upper Yakima River	2250	92	43-283	0.02	1.09	0.12	H	H		0.13	1.50			
Naches River	1500	462	140-1650	0.06	2	0.16	M	M		0.00	1.01	1.01		
Toppenish River	500	148	45-530	0.06	2.2	0.2	H	M		0.17	0.57	0.57		
Satus Creek	1000	568	172-2028	0.06	2.12	0.14	M	M		0.00	0.59	0.59		
John Day Lower Mainstem	2250	1800	563-6257	0.1	2.59	0.18	M	M		0.00	0.14	0.14		
John Day North Fork	1500	1740	961-3444	0.08	2.41	0.22	VL	L		0.00	-0.47	-0.37	0.35	
John Day Upper Mainstem	1000	524	326-1344	0.08	2.14	0.33	M	L		0.00	0.21	0.21		
John Day Middle Fork	1000	756	195-2639	0.08	1.93	0.18	M	L		0.00	0.21	0.21		
John Day South Fork	500	259	103-830	0.08	1.95	0.25	M	L		0.00	0.32	0.32		
Umatilla River	2250	1472	771-3542	0.36	1.5	0.15	M	M		0.00	0.09	0.09		
Walla Walla Mainstem	1000	1003	607-2417	0.02	1.41	0.61	M	M		0.00	-0.01	0.20	0.77	1.18
Touchet River	1000	Insufficient Data					H	M						
Willow Creek	1000	Functionally Extirpated					N/A	N/A						

a. Relative Uncertainty Adjustment: If no value presented, adjusted gap is less than Observed Gap

## **Snake River Steelhead ESU**

This ESU includes 20 extant populations occupying drainages to the mainstem Snake River, the Grand Ronde River, the Clearwater River and the Salmon River. Population specific adult abundance trend data sets are generally not available for Snake River steelhead populations. The steelhead populations in this ESU are all summer run, spawning in late spring and early summer. As a result of environmental conditions during the spawning period, it can be difficult to conduct representative surveys of the number of spawners within specific populations using redd counts or fish counts.

We have completed preliminary gap analyses for three populations in the Grande Ronde MPG (Joseph Creek, Upper Grande Ronde and Wallowa Rivers). These populations have relatively high natural abundance and productivity levels. We generated preliminary estimates of average population abundance and productivity for the remaining Snake basin populations using Lower Granite wild dam counts. This analysis assumes that hatchery returns over Lower Granite Dam are generally accounted for as rack returns, harvest, or localized spawning in the vicinity of major release points (Herb Pollard, NOAA Fisheries Boise Office, pers. comm.). We are exploring the potential for incorporating juvenile survey data at the population level as a means of breaking out regional or population level A/P estimates.

We developed estimates for two average populations representing the remaining populations within this ESU, each representing a major run type (A and B). For B run steelhead populations, we estimated productivity and abundance characteristics for an average population, assuming that natural origin returns over Lower Granite Dam were allocated proportionally among populations. The Grand Ronde populations with specific data series are classified as A run steelhead. We subtracted the estimated natural origin returns accounted for in the Grand Ronde populations from the count of natural origin A run steelhead at Lower Granite Dam. We assumed the resulting abundance time series represented the remaining A run populations and calculated abundance and productivity gaps. The majority of populations in both the A run and B run components of this ESU are classified within the Intermediate size grouping, with a minimum abundance threshold of 1,000 adult spawners.

The range in Observed Gap estimates for Snake River Steelhead populations was -0.59 to 0.65. B-run populations occupying relative high elevation tributaries in the Clearwater and Salmon River drainages would be at the high end of this range. Since the value representing the largest A/P Gap in this range is an average across populations, it is likely that the specific A/P Gaps for some of the A run populations exceed the high end of the range. Weir count based trend data sets representing relatively small components of some upper basin steelhead populations also indicate relatively low natural productivity rates.

We are developing specific model input sets using available Snake River Steelhead data. We will generate Projected Gap estimates for this ESU.

Table 6a. **SNAKE RIVER STEELHEAD ESU**. Population level statistics and Observed Gaps. ICTRT ratings for A&P (Abundance and Productivity) and SSD (Spatial Structure and Diversity). Current risk assessment results (H = high risk, M= moderate risk, L = low risk, VL = very low risk).

Population	Threshold	10-year Geomean abund.	Abund. Range	10-yr Hatchery Fraction	Productivity	Productivity SE	A&P Rating	SSD Rating	1978-2004 Harvest Rate	Observed Gaps			Relative Uncertainty Adjustment	
										25%	5%	1%	Adjusted 5% Gap	Adjusted 1% Gap
<b>SR Spring/Summer Sthd.</b>														
Tucannon River														
Asotin River														
Grande Ronde Upper Main.	1500	1832	127-9055	10%	2.29	0.18				0.00	-0.52	-0.45		
Grande Ronde Lower Main.	1000													
Joseph Creek	1000	2325	433-4626	0%	2.62	0.14				0.00	-0.59	-0.54		
Wallowa River	1000	n/a	n/a	0%	2.29	0.25								
Imnaha River	1000	n/a	n/a	0%	3.02	0.15								
CW Lower Mainstem														
Selway River														
CW South Fork														
Lochsa River														
Lolo Creek														
CW North Fork (blocked)														
Lemhi														
Upper Salmon East Fork														
Upper Salmon Mainstem														
Upper Middle Fork														
Lower Middle Fork														
Chamberlain Creek														
Pahsimeroi River														
Panther Creek														
Little Salmon River														
CW South Fork														
Secesh River														
CW North Fork														
Snake R. Hells Canyon Tributaries														
Average "b" population	1000	272	101-1558	0%	1.01	0.22	H			0.12	0.65	0.65		
Average other "a" population	1000	456	79-2580	0%	2.06	0.25	M			0.00	0.52	0.52		

a. Relative Uncertainty Adjustment: If no value presented, adjusted gap is less than Observed Gap

## **Upper Columbia Steelhead ESU**

This ESU is currently limited to four extant populations in one Major Population Grouping. The MPG historically included a fourth population in the Crab Creek drainage, it is believed to be functionally extinct. Two additional MPGs likely existed, the tributaries that supported them are now cut off from anadromous access by Grand Coulee and Chief Joseph Dams.

The ICTRT has recommended that two populations from this group be targeted for very low risk to compensate, in part, for the loss of the upriver populations in this ESU. The median Observed A/P Gap (5% risk curve) for the four extant populations in this ESU is 5.57, ranging from 3.33 (Wenatchee) to 7.69 (the Okanogan).

As an interim approach, we applied the historical climate adjustment and recent hydro survival factors developed for Upper Columbia Spring Chinook to generate Projected Gaps scenarios for Upper Columbia Steelhead populations. Under the 100 year ocean scenario and assuming recent average hydropower system related survivals continue, the median 5% risk gap would decrease to 3.29 (1.83 to 4.67). The gaps relative to the 1% risk curve under this scenario would be 4.29 and 2.35 for the Methow and the Wenatchee populations, respectively.

Returns from large scale hatchery programs have dominated natural spawning in these systems for more than 30 years. The recent 10 year average proportion hatchery origin on the spawning grounds for the Upper Columbia populations has been high: Methow (0.89), Okanogan (0.92), Wenatchee (0.73), and Entiat (0.73). As a result there is a significant possibility that current productivity of natural spawning steelhead in the upper Columbia has been affected and is depressed from historical levels. For example, assuming that the relative effectiveness of an average hatchery origin spawner is 0.3 and that natural productivity could be restored over time, the Observed A/P Gap relative to the 5% risk criteria would drop from 3.33 to 1.00 for the Wenatchee, with an even greater drop for populations with greater hatchery percentages (the Methow and Okanogan populations).

Table 7a. **UPPER COLUMBIA STEELHEAD ESU**. Population level statistics and Observed Gaps. ICTRT ratings for A&P (Abundance and Productivity) and SSD (Spatial Structure and Diversity). Current risk assessment results (H = high risk, M= moderate risk, L = low risk, VL = very low risk).

Population	Threshold	10-year Geomean abund.	Abund. Range	10-yr Hatchery Fraction	Productivity	Productivity SE	A&P Rating	SSD Rating	1978-2004 Harvest Rate	Observed Gaps			Relative Uncertainty Adjustment	
										25%	5%	1%	Adjusted 5% Gap	Adjusted 1% Gap
<b>Upper Columbia Steelhead</b>														
Wenatchee (hatchery eff.=1)	1500	900	427-3848	0.73	0.3	0.39	H	H	0.08	2.57	3.33	4.13	3.72	4.63
Methow (hatchery eff.=1)	1500	309	101-780	0.89	0.19	0.63	H	H	0.1	4.79	5.84	7.11		
Entiat (hatchery eff.=1)	500	94	45-404	0.73	0.26	0.35	H	H	0.08	3.35	5.31	7.46	5.66	7.91
Okanogan (hatchery eff.=1)	1000	114	37-288	0.92	0.16	0.42	H	H	0.1	5.94	7.69	9.44		

a. Relative Uncertainty Adjustment: If no value presented, adjusted gap is less than Observed Gap

Table 7b. **UPPER COLUMBIA STEELHEAD ESU**. Required change in survival projected to meet abundance and productivity criteria for 25%,5% and 1% Risk Curves under a range of ocean/hydropower survival scenarios. Projected A/P Gap is the survival improvement projected as necessary to meet a particular risk criteria after accounting for survival adjustment. Average hydropower and harvest survival levels. Gap estimates are expressed as a proportion of current survival. A gap of 0.5 requires increasing average life cycle survivals by 50% (multiplying by 1.5) over recent average.

Upper Columbia Steelhead	Estimated Abundance/Productivity Gap Scenarios ( 25% Risk Curve)																	
	Recent Ocean Survival						Historical Ocean Survival						Pessimistic Ocean Survival					
	PDO Model		PDO/WTT/UPW Model		Explicit Delayed Mortality Model		PDO Model		PDO/WTT/UPW Model		Explicit Delayed Mortality Model		PDO Model		PDO/WTT/UPW Model		Explicit Delayed Mortality Model	
	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro
Upper Columbia Steelhead																		
Wenatchee (hatchery eff.=1)	2.57	2.05					1.72	1.33					3.35	2.88				
Methow (hatchery eff.=1)	4.79	3.95					3.42	2.78					6.06	5.30				
Entiat (hatchery eff.=1)	3.35	2.71					2.32	1.84					4.30	3.73				
Okanogan (hatchery eff.=1)	5.94	4.93					4.30	3.53					7.46	6.55				

Upper Columbia Steelhead	Estimated Abundance/Productivity Gap Scenarios ( 5% Risk Curve)																	
	Recent Ocean Survival						Historical Ocean Survival						Pessimistic Ocean Survival					
	PDO Model		PDO/WTT/UPW Model		Explicit Delayed Mortality Model		PDO Model		PDO/WTT/UPW Model		Explicit Delayed Mortality Model		PDO Model		PDO/WTT/UPW Model		Explicit Delayed Mortality Model	
	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro
Upper Columbia Steelhead																		
Wenatchee (hatchery eff.=1)	3.33	2.70					2.31	1.83					4.28	3.72				
Methow (hatchery eff.=1)	5.84	4.85					4.22	3.46					7.34	6.45				
Entiat (hatchery eff.=1)	5.31	4.39					3.82	3.12					6.69	5.87				
Okanogan (hatchery eff.=1)	7.69	6.43					5.63	4.67					9.59	8.46				

Upper Columbia Steelhead	Estimated Abundance/Productivity Gap Scenarios ( 1% Risk Curve)																	
	Recent Ocean Survival						Historical Ocean Survival						Pessimistic Ocean Survival					
	PDO Model		PDO/WTT/UPW Model		Explicit Delayed Mortality Model		PDO Model		PDO/WTT/UPW Model		Explicit Delayed Mortality Model		PDO Model		PDO/WTT/UPW Model		Explicit Delayed Mortality Model	
	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro	Base Hydro	Recent Hydro
Upper Columbia Steelhead																		
Wenatchee (hatchery eff.=1)	4.13	3.39					2.92	2.35					5.26	4.59				
Methow (hatchery eff.=1)	7.11	5.93					5.19	4.29					8.88	7.83				
Entiat (hatchery eff.=1)	7.46	6.23					5.46	4.52					9.32	8.21				
Okanogan (hatchery eff.=1)	9.44	7.92					6.97	5.81					11.73	10.36				